Exploring the Interior Exposome Using Citizen Science: Initial Results From the New DustSafe Initiative

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Abstract

Studies of interior air exposures to various human and non-human components has largely been restricted to industrial exposures for the purpose of regulation. In contrast, little attention has been paid to exposure at the residential scale, where people spend much of their day and may be exposed to particulate sources ranging from known toxins, such as lead, arsenic, and asbestos, to human-produced chemicals of yet unknown toxicity, such as flame retardants. To capitalize on experience with citizen science initiatives as they pertain to environmental health, researchers formed an international network called 360 Dust Analysis, which provides guidance on citizen science and interior dust collection, as well as research tools to examine dust through analysis in regional labs. We present initial results from the July 2018 launch of this program in the USA, called DustSafe USA and operated under approved human subjects protocols by Indiana University (http://www.urbanhealth.iupui.edu/). We launched via multiple media strategies, including an extended television news segment, an article in several Indiana newspapers, appearances in several statewide radio shows, and via a widely distributed press release. As of this abstract submission, well over 300 queries were received, and after only two weeks of the launch the lab has received nearly 100 dust samples. Participants are largely from central Indiana where most of the media play occurred, but samples have also come from all over the country. We will present geochemical and compositional results from the dust analysis, but perhaps more importantly we will discuss how citizens were engaged, how the funding model for such efforts might be developed, and the general approach to research translation and citizen science.

Exploring the Interior Exposome Using Citizen Science

Initial Results From the New DustSafe Initiative

Gabriel Filippelli, Emeline Frix (Earth Sciences, IUPUI; gfilippe@iu.edu); Mark Patrick Taylor (Environmental Sciences, Macquarie University, Sydney); Jane Entwistle (Earth Sciences, Univ. of Northumbria)

Justification

Studies of interior air exposures to various human and non-human components has largely been restricted to industrial exposures for the purpose of regulation. In contrast, little attention has been paid to exposure at the residential scale, where people spend much of their day and may be exposed to known toxins, such as lead, arsenic, and asbestos, to human-produced chemicals of yet unknown toxicity, such as flame retardants. To capitalize on experience with citizen science initiatives as they pertain to environmental health, researchers formed an international network called 360 Dust Analysis, which provides guidance on citizen science and interior dust collection, as well as research tools to examine dust through analysis in regional labs.

DUSTSAFE INDIANAPOLIS PROGRAM - Consent Form

Thank you very much for participating in our indoor dust analysis program led by Professor Gabriel Filippelli.

You are being asked to participate in research related to indoor environmental quality. As part of your participation in this program, we need to collect some data about your household to assist in interpreting the results. After completing this questionnaire, you will then collect and submit a dust sample to the program, which we will analyze for lead and chromium (two common metals of significant health concern) and provide that information back to you after analysis is completed. We will also be collecting other environmental data which relates to a greater understanding of the distribution and variation in indoor house environment as part of this research.

We will use the results to produce maps, graphics, tables and figures showing the information. Your participating is voluntary. The risk of participation is minimal, and is limited to the stress should we discover unsafe levels of potentially harmful metals inside your home. The benefits include a greater understanding of your indoor environment, and gaining a greater understanding of the environment through participation in this citizen-science research.

The data will be de-identified to the extent that no address or other information will be included that can be used to specifically identify the precise locations of the samples. We may also use the results with your permission, in future publications, again with the aforementioned limitations.

Therefore, in completing this questionnaire, you acknowledge consent for these purposes.

If you decide to participate, **print and complete this questionnaire**, which provides important information about your residential environment, and submit it and your labelled vacuum dust **(include your name, residential address, and email address with your vacuum dust) to:**

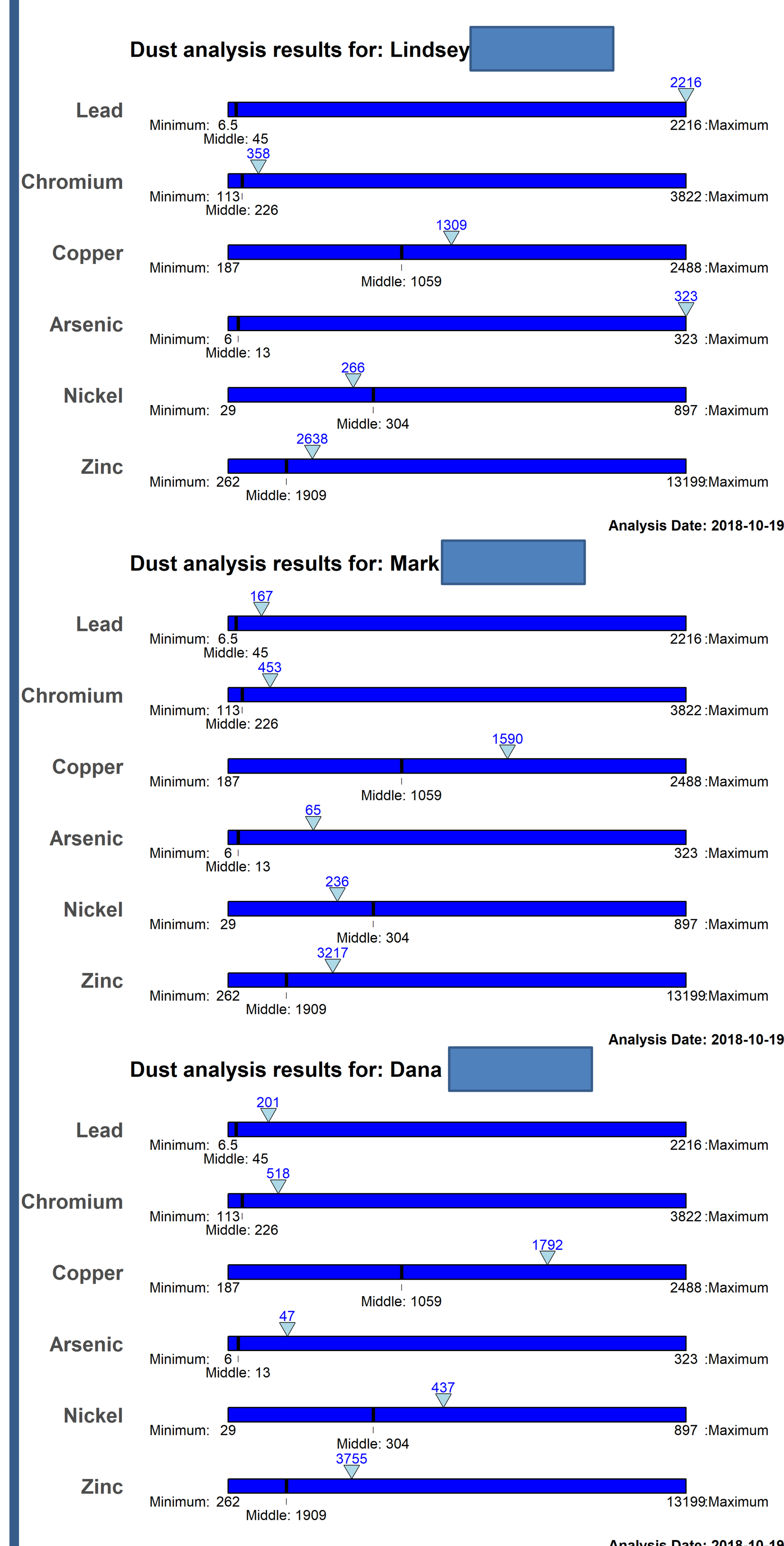
Professor Gabriel Filippelli
DustSafe North America
Center for Urban Health, IUPUI
723 W. Michigan St.
Indianapolis, IN 46202
Email: cuh@iupui.edu

We will provide a summary of the results and links to documentation to provide guidance on dust metal exposure. We typically take about 2 weeks to complete the analysis and return the results. Should you have any questions about this research project, please contact Dr. Filippelli at the address above.

Progress to Date

This international program launched in July in the US, called DustSafe NA and operated under approved human subjects protocols by Indiana University (http://www.urbanhealth.iupui.edu/). We launched via multiple media strategies, including an extended television news segment, an article in several Indiana newspapers, appearances in several statewide radio shows, and via a widely distributed press release. **We have analyzed over 300 dust samples from around the US.**

Research Translation Approach



Hello Citizen scientist!

Thank you for participating in the DustSafe North America program, run through the Center for Urban Health at IUPUI! Your participation greatly enhances our understanding of the indoor environment, and is the first such citizen-science program on this topic of its kind.

Results of your indoor dust analysis

You are receiving the results for the dust that you submitted to the program. As noted in the original questionnaire, this initial effort focuses solely on heavy metals, many of which have very strong and negative impacts on human health. Of course, there are many other components of the indoor environment that may be of concern, such as allergens and flame-retardants, but these are outside the scope and financial scale of what we can provide at the moment. We do plan to use this initial pilot to show how successful such a program can be, and to gain outside support to include these other measurements in our program.

We have retained your dust sample, and should we be able to obtain funding, we will conduct tests on these components and relay the information back to you. We will be developing a web-based portal shortly, where you can log in and see the latest results from your tests. Once that is created, we will reach out to you again.

What your values mean

Your specific results are included as another attachment on this email. No safety guidelines currently exist for heavy metals in home dust. But using the US soil guidelines, levels (in ppm or parts per million) above the following for these targeted metals are considered unsafe:

Lead	400 (European standard is 80)
Arsenic	16
Nickel	140
Zinc	2200

In the attached figure, we provide the range of values, including the minimum and the maximum, for all samples tested to date. You will see the middle point, or median, of all of the values determined. Your particular home dust sample is indicated as an inverted triangle for each metal on that scale.

What can be done to reduce your levels

Several simple steps can ensure that your home is as safe as it can be. Simply using a damp cloth for dusting, cleaning your floors with a modern vacuum equipped with a vacuum HEPA filter, and occasionally wet-mopping your floor are all good ways to make sure that the dust is removed from your home without getting into you or your children. More information about the program, and how to make your home more metal-free, can be found here:

https://www.wthr.com/article/whats-your-dust-iupui-experts-test-contaminants-your-home

For any further questions, do not hesitate to contact us at cuh@iu.edu

Indoor Dust as an Issue

Only a handful of studies have examined indoor dust metals concentrations at the residential scale. Two recent analyses reveal that the modeled levels of human uptake of some of these dust metals is concerning, and thus should be examined more closely. Additionally, these studies did not specifically examine the issues around children in homes, which is one of the foci of our efforts.

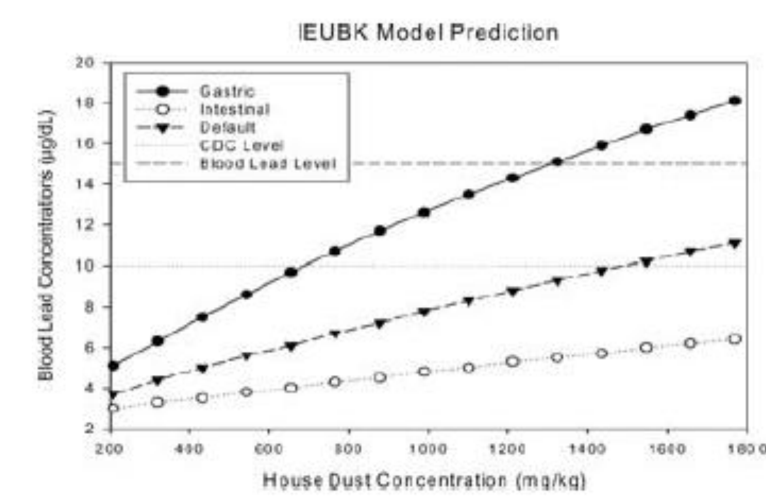


Fig. 4. The comparison of IEUBK model predictions for obtained gastric bioaccessibility (65%), intestinal bioaccessibility (12%), and model default value (30%).

Table II. The Bioaccessibility Test for 15 Vacuumed House Dust Samples (Mean ± SD%)

Home ID	Total Lead Concentration (μg/g)	Gastric Bioaccessibility (%)	Intestinal Bioaccessibility (%)
001	1097	76.6 ± 3.1	6.7 ± 0.3
002	596	74.3 ± 14.5	6.7 ± 0.2
004	216	70.1 ± 4.5	8.5 ± 0.7
005	1125	68.9 ± 0.5	17.8 ± 0.7
006	358	71.3 ± 3.5	7.3 ± 1.1
007	1312	74.7 ± 2.2	6.0 ± 0.2
009	709	77.2 ± 0.9	11.1 ± 0.2
010	487	52.7 ± 1.4	32.1 ± 0.7
013	732	55.8 ± 1.4	4.9 ± 0.2
014	209	57.0 ± 1.9	9.3 ± 0.7
016	820	72.6 ± 2.7	5.75 ± 0.2
021	676	59.9 ± 2.0	12.3 ± 0.7
023	1770	55.1 ± 2.1	6.4 ± 0.2
027	813	52.4 ± 1.1	28.8 ± 2.1
029	541	53.7 ± 0.3	17.7 ± 0.9
Mean ± SD	764.1 ± 422.5	64.8 ± 9.4	12.1 ± 8.2

Yu et al., 2006. The bioaccessibility of lead (Pb) from vacuumed house dust on carpets in urban residences. Risk Analysis, 26(1) 125-134.

Table 2. Levels of heavy metals in soil used to guide cleanup and land use decisions (mg/kg)

	US EPA	NYS DEC	
	Soil level requiring clean-up	Unrestricted use*	Residential use
Copper (Cu)	--	270	270
Cadmium (Cd)	70	0.43	0.86
Chromium (Cr)	230	11	22
Nickel (Ni)	1600	72	140
Lead (Pb)	400	200	400
Zinc (Zn)	23,600	1100	2200

*Includes agricultural use.

Table 3. Soil lead contamination levels and recommended actions.

Contamination level	Total Lead in soil mg/kg		Recommended Action
	PA	NJ	
none / very low	< 150	< 100	No need to be concerned about lead exposure.
low / elevated	150 - 400	100 - 300	Conduct best management practices (BMPs) to minimize lead exposure from vegetable gardens: apply phosphate fertilizer, maintain high pH for fruiting vegetables, keep soil mulched to minimize dust and lead inhalation.
medium / significant	400 - 1000	300 - 400	Conduct BMPs; do not grow leafy vegetables.
high / cleanup	> 1000	> 400	Do not grow a vegetable garden. Contact local health department for lead abatement measures.

US regulatory standards for soil metals—note that no such recommendation exists for household dust

Pilot summary results

Left panel for DustSafe Australia; right panel summary not including DustSafe NA

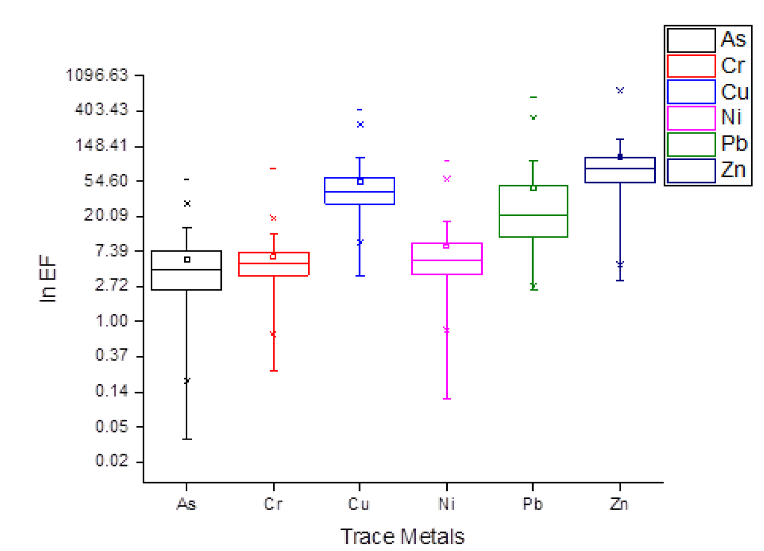


Table 1. Mean and median dust metal concentrations (mg/kg). LOD = limit of detection (4 mg/kg)

Element	Australia (n=95) Mean	Australia (n=95) Median	Sydney (n=52) Mean	Sydney (n=52) Median
As (arsenic)	17	13	12	111
Cd (cadmium)	<LOD	<LOD	<LOD	<LOD
Cr (chromium)	82	66	78	67
Cu (copper)	214	173	237	201
Mn (manganese)	206	189	197	176
Ni (nickel)	43	31	47	36
Pb (lead)	381	405	399	149
Zn (zinc)	1525	931	1448	1001